Defra's Water Availability and Quality Evidence Programme

Comparative Costings for Surface Water Sewers and SuDS.

Marlborough Road, Telford, Shropshire.

R&D Technical Report

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1. Location

1.1 The development is located in Hadley, in the northern part of Telford, Shropshire, within Telford & Wrekin Borough (a unitary authority). Hadley has had a long history of industry ranging from extractive industries (coal and brick clay) to heavy and light engineering production. Since the development of Telford New Town from 1968 onwards, Hadley has seen more manufacturing and related land uses develop. The industrial base has seen significant changes over the last 100 years and change has been a theme over the past 10 or so years. The major brickworks has declined in output and even some of the newer industries have now closed down. This has meant that alternative uses have had to be found for underused and cleared sites. Many of these sites have been re-used for housing.

1.2 The locality is underlain by dense, impermeable clay (known as Etruria Marl), whilst to the south the land rises onto the coal measures which have been extensively mined.

1.3To the east, the site is bounded by the brickworks and to the south and west by established housing mostly dating from the 1930s and 1950s. Marlborough Road connects the site with this earlier development and to the centre of Hadley in the west and links to Sommerfield Road in the east.

1.4 Telford remains a fast growing town and at the time this estate was built was expanding at about 800 new homes per year.

1.5 The highway adoption is the responsibility of Telford & Wrekin Council. The Council's engineers have also provided advice on drainage, land stability and land quality. The sewerage systems (foul and surface water) have been vetted directly by Severn Trent Water.

1.6 The National Grid Reference of the site is: SJ 681121.

2. Site Characteristics

2.1 This is a 11.24ha site which was developed between 2002 and 2004 and lies for the most part on 'brownfield' land which formed part of the brickworks. The site slopes moderately and generally to the north and east and is underlain by the dense, impermeable clay.

2.2There was formerly a small watercourse flowing south to north adjacent to the site, but this was incorporated within the surface water sewerage infrastructure provided to enable the development of the New Town in the 1970s. The only outfalls for surface water from this site are therefore to a surface water sewer that flows west to east beneath Trench Lock, the road which forms the northern boundary of the site, and to a similar sewer that flows beneath Sommerfield Road which is situated to the east of the site. These two sewers join and then connect to a large diameter sewer tunnel which outfalls into an engineered open channel system that discharges into the River Tern about six kilometres to the north west. This surface water sewerage system conveys a significant pollution load from the urban area. In accordance with normal Environment Agency practice for surface water sewers, the discharge to the river is not consented. The engineered open channels that convey the water to the river are mostly along the routes of former small watercourses and are trapezoidal in cross-section and lined with

gabions. Without this engineered lining, the peak discharges from the sewerage system could not have been handled without significant erosion and environmental damage. The open channels are not an attractive feature and support little biodiversity.

2.3 To the east the site is bounded by the active brickworks and to the south and west by established housing mostly dating from the 1930s and 1950s.

2.4 The Marlborough Road estate has a mix of housing types ranging from mid-sized detached houses, through three storey town houses to terraced houses and three and four storey flats. The majority of the development comprises smaller, 'starter home' units. A large proportion of these have been bought on a buy-to-let basis. The development therefore has both a high occupancy and most residents have cars.

2.5 The development is laid out to a modern, high-density layout with features such as:

- Narrow highways with sharp bends and other traffic calming features.
- Terraced housing with very small gardens.
- A high level of parking provision.
- Parking courtyards, some of which are fronted by garages with flats above.
- Shared surfaces which serve several properties.

2.6 It is generally well designed, with attractive houses and attention paid to the materials used and to high quality hard and soft landscaping. For example most unadopted parking courts and linking walkways are brick paved (with clay paviors) and most green areas provided attractive settings for some of the houses. Because of the high density and high level of parking provision impermeable areas are large.

3. The Highway Layout

3.1 The site has a complex, convoluted highway layout which facilitates high density development. The layout and detailing have clearly been considered at the earliest stages of the development concept and have been well thought through, with regard to access and to integrated traffic calming.

3.2 Marlborough Road forms the only vehicular route which passes through the estate.

3.3 The Council as highway authority, has a reluctance to adopt brick paving. As a result, the more heavily trafficked highways are surfaced with tarmacadam as are many of the adoptable footways. Brick paving is however to be found in certain adoptable areas. There are a large number of unadopted parking courts and shared driveways each of which serve several properties. These all function as shared surfaces, used by vehicles and pedestrians and are mostly brick paved. All of the highway drainage and the drainage of unadopted surfaces is to conventional gullies.

4. The Surface Water Drainage System as Built

4.1 Surface water drainage is all to a traditional pipe system which largely follows the highway network. The main system flows northwards to connect to

the main surface water sewer in Trench Lock. The extreme eastern part of the site and the section of Marlborough Road linking to Sommerfield Road are drained via a separate surface water system to the sewer in Sommerfield Road. The sewered solution is shown in Appendix 1.

4.2 All of the properties are drained by private drains and private sewers to the public sewerage system which was adopted through a Section 104 agreement under the Water Industry Act.

4.3 The highway gullies are connected to the adopted surface water sewers via pipe connections. There are no separate highway drains.

4.4 As the site connects to established surface water sewers which had capacity to receive the 1 in 30 year flows from the development, there are no flow attenuation features within the development and none at the points of connection to the existing sewers.

4.5 Whilst there is very extensive use of brick paving throughout the development, none of this is porous paving. There no other SuDS features, although some householders may have installed rainwater butts.

5. The SuDS Concept

5.1 Subsoil conditions within this site do not permit a reliance on infiltration techniques. The SuDS concept is therefore one which relies upon attenuation storage and slow conveyance. The main conveyance route is to the east to the ‘village green’ in Marlborough Road and then to the north along a green corridor. A secondary conveyance system serves the small part of the site to the east and the section of Marlborough Road which connects to Sommerfield Road. Essentially the flow routes are similar to those employed in the surface water sewer design. The concept is shown in Appendix 2.

5.2 Surface water from the highway is drained into porous surfaces and/or on the surface via short routes to swales or basins. The concept assumes the surfaces are shaped to fall toward the swales and/or basins. The subgrade beneath the porous surfacing is assumed to be shaped to gentle falls towards filter drains.

5.3 Because of the density of the development, there are relatively few opportunities to use swales, but there are grass verges along Marlborough Road which are assumed to be shaped into swales with under-drainage. It has been practical to place basins in many of the other surfaced and open areas.

5.4 Experience indicates that with high car ownership, parking of vehicles on verges and swales can sometimes be problematic. Therefore it has been assumed that a kerb with drainage openings in the face is provided between the carriageway and the swales. Alternative solutions to this issue could be ‘hit and miss’ kerbs, bollards, low ‘trip rail type of fencing and/or shrub planting at the edge of the swale/basin and these may be suitable in some parts of the site.

5.5 The principles employed for the SuDS are:

a) Source Control:

- Porous paving of the house driveways.
- Porous paving of the adopted cul-de-sacs and unadopted parking courts and shared driveways. It is assumed that the more heavily trafficked spine road through the site is surfaced with conventional tarmac.
- Roof water 'disconnection' with downspouts discharging to rainwater butts which overflow to individual filter drains (or garden swales where there is space) and/or into the porous stone structure beneath the porous paved parking courts and shared driveways and with residual discharge passing to the adoptable swales and basins.

b) Local Control:

Adoptable swales, detention basins and ponds which form a continuous, slow conveyance system, which in general follows the same routes as the surface water sewers did.

The swale system works at two levels:

1. A surface based swale system (with the main swales 1.8m wide and of 'V' section, with a depth of 0.3m).
2. A slightly deeper, porous pipe system which sits beneath the centre line of the swales. This deeper system is intended to take flows beyond the capacity of the surface swales and there are 20 grated inlets from the surface swales to the lower system.

The swales are located where there is grass verge and roadside landscaping.

The basins have been assumed to be shallow, generally not more than about 400mm deep so that they will have opportunity to lose water through evaporation and slight infiltration but will not retain more than about 100mm depth in drier periods of weather. It is assumed that they will be landscaped and may have some shrubs and trees around and within them. They have been made as large as reasonably possible in area and have been located wherever the site layout had some available space. They have all been placed in visible areas which have direct connectivity to either the highway or to other open space (for oversight and maintenance). The locations comprise:

- Public open space - Here, they have generally been placed in what would otherwise be less usable corner positions so as to retain the availability of larger, flat grassed areas for recreational games.
- Some highway areas - Here, flank frontages of properties have provided opportunities, as have visibility splays at junctions and peripheral garden space in awkward shaped plots. In these cases, it is assumed that the land occupied by them would become public open space or would be covered by an easement to allow the SAB to maintain them.

Ponds are provided in a number of places. These are located within those more extensive and very visible green areas within the site which do not provide play space for children. The site includes a sizeable, 'feature village green' which forms the setting for town houses at the eastern end of the site. It is assumed the central part of this area hosts a pond and that this will be available for flow storage via fluctuating water levels and adjacent floodable area for more extreme events. Clearly it is assumed that this pond will provide enhanced landscape value to its setting.

A similar approach is taken to the green corridor to the north of the 'village green'. Here, it is assumed that a linear pond feature with permanent water is provided and flow storage is provided within the system. In this location there is opportunity to use the feature to enhance the landscaping which is rather bland.

5.6 In order to provide full continuity within the surface system of swales, basins and ponds, some sections of pipe (200mm diameter) are necessary beneath highways. This is particularly the case at junctions. Because these sections of pipes are extremely shallow, protecting 'cover' (and space for a concrete surround) has been secured by through the traffic calming features. These features increase the total cover to about 250mm.

5.7 In all cases where a basin or swale discharges into a pipe or a pipe discharges into a basin or swale, no engineered headwalls or gratings would be built (the concept assumes that all pipe entries are formed by shaping the swale around them). Care has been taken to ensure that all connections between piped sections occur in the open at basins and swales. There are no manholes within the concept.

5.8 It is assumed that flow control devices would be provided at the outlets to the larger ponds and at immediately prior to the connections to the sewerage system.

5.9 The 'under-draining' pipes beneath the swales form a fully connected system that is independent from the surface system of swales and shallow pipes (being connected only by the specific inlets). The 'under-draining' pipes sit within a trench of standard pipe trench width for the pipe sizes (mostly 250mm diameter and 300mm diameter at the downstream end) and have pipe soffit 150mm below the swale invert giving a maximum depth of these pipes to invert of the order of 750mm. This is a comfortably safe depth for excavation work without the need for expensive trench support systems and the scale of these works will yield relatively small amounts of surplus material for disposal. Access to this system for any maintenance work is via the inlets from the swales.

5.10 The concept does not envisage adoptable SuDS requiring significant areas of private space within housing plots being brought into the public realm to accommodate SuDS features. There may be some small adjustments of property boundaries (e.g. along flank frontages) to provide a small amount of additional space. Such adjustments are marginal and seen as having no cost as they would be made at the time of designing the development and would have no effect on the attractiveness of plots for sale. Within the concept, all adoptable, *local control* SuDS features are placed within areas where oversight is available. The features are either within:

- Adopted highway areas.
- Landscape areas that have been adopted by the local authority. Although these are adopted by the local authority (in this case unitary), formal arrangements could be put in place to cover the situation within the two tier local government system (where landscape may be taken over by the district tier) and the fact that the SAB role is a distinct area of responsibility. This could be done by easements being established by the developer as the estate was laid out to safeguard the SuDS.

- Shared access features such as parking courts or shared driveways. Whilst these areas are not adopted, the SuDS features would be reasonably secure from third party damage because these areas cannot be altered by any one property owner. However, it is envisaged that full security for the SuDS features in such areas would be provided by easements established by the developer as the estate was laid out.

5.11 The concept provides for the source control and local control system to deal with the 1 in 30 year event.

5.12 The 1 in 100 year event is managed by securing a viable, continuous flood route through the development generally along the route of the conveyance system.

6. The Estimates

6.1 These are shown in Appendix 3. The approach taken with the estimates has been to identify only those elements of the development that change between the sewered and SuDS concepts and then to estimate the difference in the total costs of these changes. The changes are principally in connection with the drainage infrastructure itself (e.g. swales instead of sewers) and surfaces (e.g. porous paving in some areas instead of other brick paving and tarmac). The estimates therefore represent only a proportion of the total infrastructure costs of the development.

6.2 The rates used are local ones from Telford & Wrekin Council's annually tendered minor works contract. These rates have been used consistently for all of the estimating for both the SuDS and the sewered options in order to have a sound basis for comparison.

6.3 There is little doubt that a bespoke, tendered contract for each of the concepts would have secured lower rates and lower out-turn costs for both the sewer and SuDS schemes.

6.4 The total estimated cost for the sewer features is £1,074,528.
The total estimated cost for the SuDS features is £966,119.
This represents a saving per unit of the order of £280 with the SuDS concept.

7. Opportunities for SuDS if the site concept and layout had been modified

7.1 As the layout of this development has been largely determined by the need to achieve the high density and by the main access route, there is probably not huge opportunity to suggest significant ways in which the layout itself could have been made more 'SuDS friendly'. The exercise has in fact shown that this development is quite readily adaptable to a SuDS solution. Clearly, there would have been some opportunities to improve the implementation of SuDS had they been considered within the initial concept, particularly in the ways in which some open space areas could have had more than one use (within e.g. amenity, recreation, parking, surface water management). Whilst this development has a broad mix of dwelling types (two storey terraced houses, three story town houses and three and four storey flats), the designers of this development have wished to use traditional features such as tiled pitched roofs consistently. If the concept had a brief

with modernist features such as flat or gently sloping roofs, then there would have been opportunity to utilise green roofs.

7.2 One is left with a view that this development has benefited from generally good planning and detailed design (an example in this respect being the way in which the highway concept and detailing support the high density) and that the design team could have successfully factored in a good quality SuDS solution within the overall concept.

8. Benefits

8.1 Even though this is a generally well designed development, the use of SuDS would probably have had the effect of enhancing the attractiveness of the estate. The SuDS would enable some of the paved areas to be softened by introducing more trees and shrubs and other surface detail. There are areas of paving within the estate where bollards have been used to separate the parts which can be driven over from the ones where it is desired to exclude cars. This is not a particularly neat solution and SuDS features could easily have been used to provide this separation. Biodiversity within a high-density development of this type is not a particularly strong theme and use of SuDS would greatly enhance this aspect; in particular through the basins and ponds.

8.2 The storage and attenuation provided by the SuDS would have had the effect of reducing the burden on the public sewerage system. Although this system is capable of taking the unattenuated 1 in 30 year storm event from this estate, attenuation of the flows would have conserved capacity for other developments and re-developments in the area. This would help to secure better value from the substantial investment in the sewerage infrastructure that has taken place over the past 20 years and reduce the risk of expensive and disruptive upsizing of sewers at a later date. Attenuation of flows from this estate would also have had the effect of giving more resilience to the downstream system in events beyond 1 in 30 years.

8.3 The slow conveyance and attenuation of flows will have the effect of removing pollutants and reducing the current pollution load carried by the surface water sewer system into the open channels and river. This would improve their water quality, amenity and biodiversity.

8.4 As most of the SuDS features are visible within the estate, they will be subject to oversight by the residents. In this way the features can provide an educational resource and evidence to the residents that their development is placing reduced demands upon the wider environment. Simple, surface SuDS features such as the ones which could be used here, can lend themselves to local, co-operative maintenance by residents, particularly as risks and skill requirements are both very low. Where co-operative inputs are mobilised, they can have beneficial effects in helping to build a stronger and safer community.

9. Lessons Learnt

9.1 The SuDS concept has been developed by considering numerous themes in a holistic manner. These include:

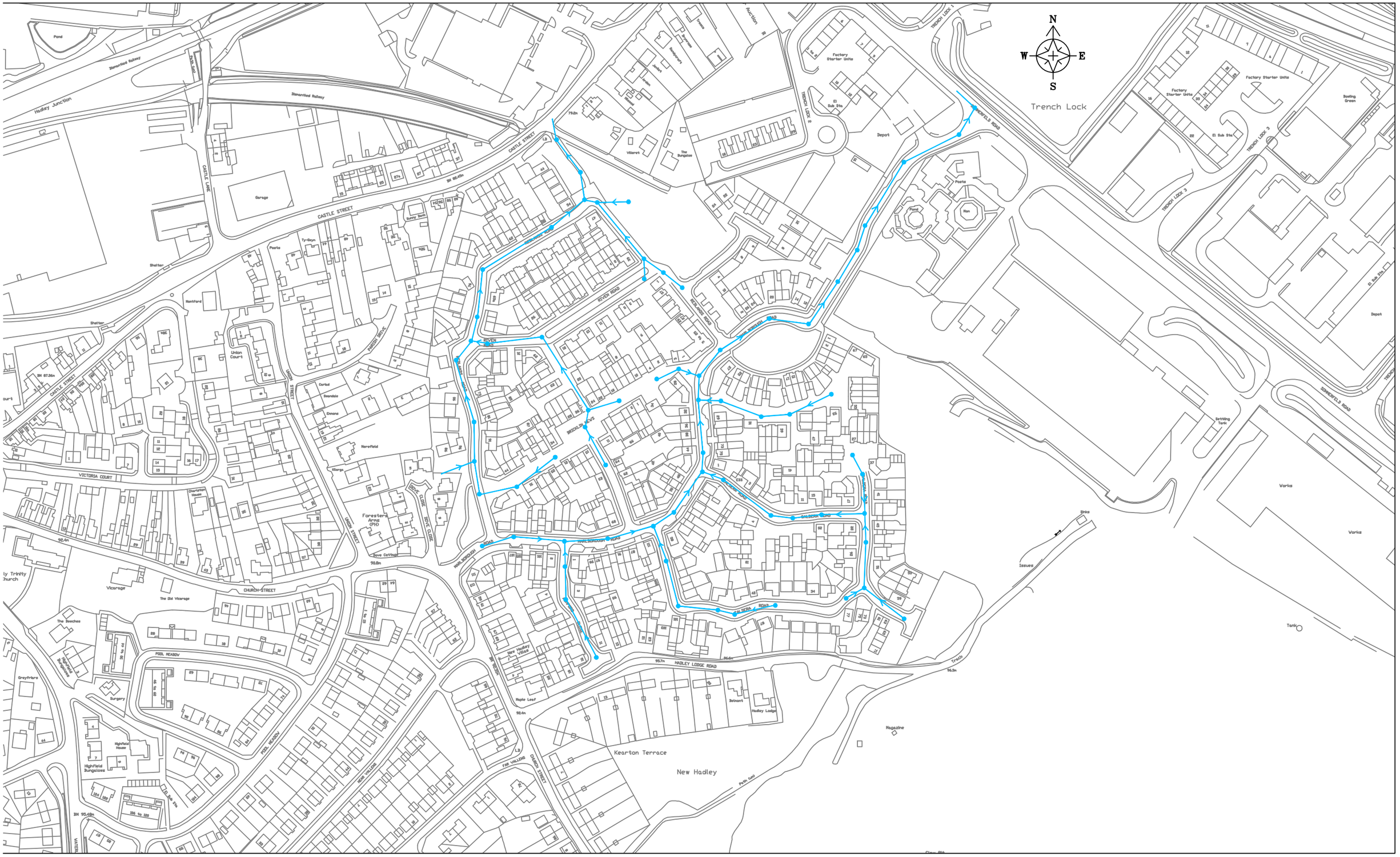
- Minimising impacts upon the layout and detailing within the estate as the design of the high-density layout will already have had to broker a range of planning and other requirements.
- Aesthetics within the development.
- Residents needs.
- Access within the development for service vehicles.
- Access to all properties by vehicle and foot.
- Traffic safety.
- SuDS safety.
- Access to SuDS features for inspection and maintenance.
- What can be expected of residents and visitors in terms of parking culture.
- Using 'green spaces' for both landscape and surface water management.
- A viable flood route.

9.2 In particular the work has shown that it should be possible to incorporate SuDS into well designed, high-density developments. This SuDS scheme has involved minimal alteration to the development and highway concept and does not weaken any of the design principles that have been adopted. The main changes from the original design are:

- The use of porous paving. The use of porous paving in the adoptable highway areas would need the co-operation of the highway authority.
- The introduction of swales instead of verges. This again would require the co-operation of the highway authority. Within this estate, even with its large number of cars to be parked, there is no evidence of parking on the existing verges and therefore no reason why swales would be impractical.
- The introduction of basins. Within the highway areas this would require the co-operation of the highway authority. Within the highway areas and in other areas, these basins should have a positive benefit in terms of landscape. As this is a high density development, there are limited numbers of trees and shrubs. The relatively small opening up of surfaced areas to provide these basins will also give opportunity for some landscaping which would break up some of the more extensive, bleaker paved areas.
- The introduction of ponds into some of the green landscape areas. This would not detract from the use of these areas as they are mostly currently seen as providing passive amenity value. The introduction of open water will have the effect of strengthening the visual amenity of these areas and provide biodiversity value. Where green areas also have a role of providing play (or 'kick about') space, then they have not been selected for ponds. Instead, the fringes of the areas have been used for swales or linear basins that would be designed to be self draining.

10. Summary

10.1 The exercise has shown that a high-density development is amenable to a SuDS drainage solution which is compliant with the proposed Standards and which can provide added value to the development. It also indicates that SuDS in this type of development can offer a cheaper drainage solution than traditional sewers. The exercise has confirmed the key role that highway adoption standards and design will play in securing good SuDS solutions. In a development such as this with a good design concept and good detailing, SuDS ought not to be a difficult theme to incorporate.

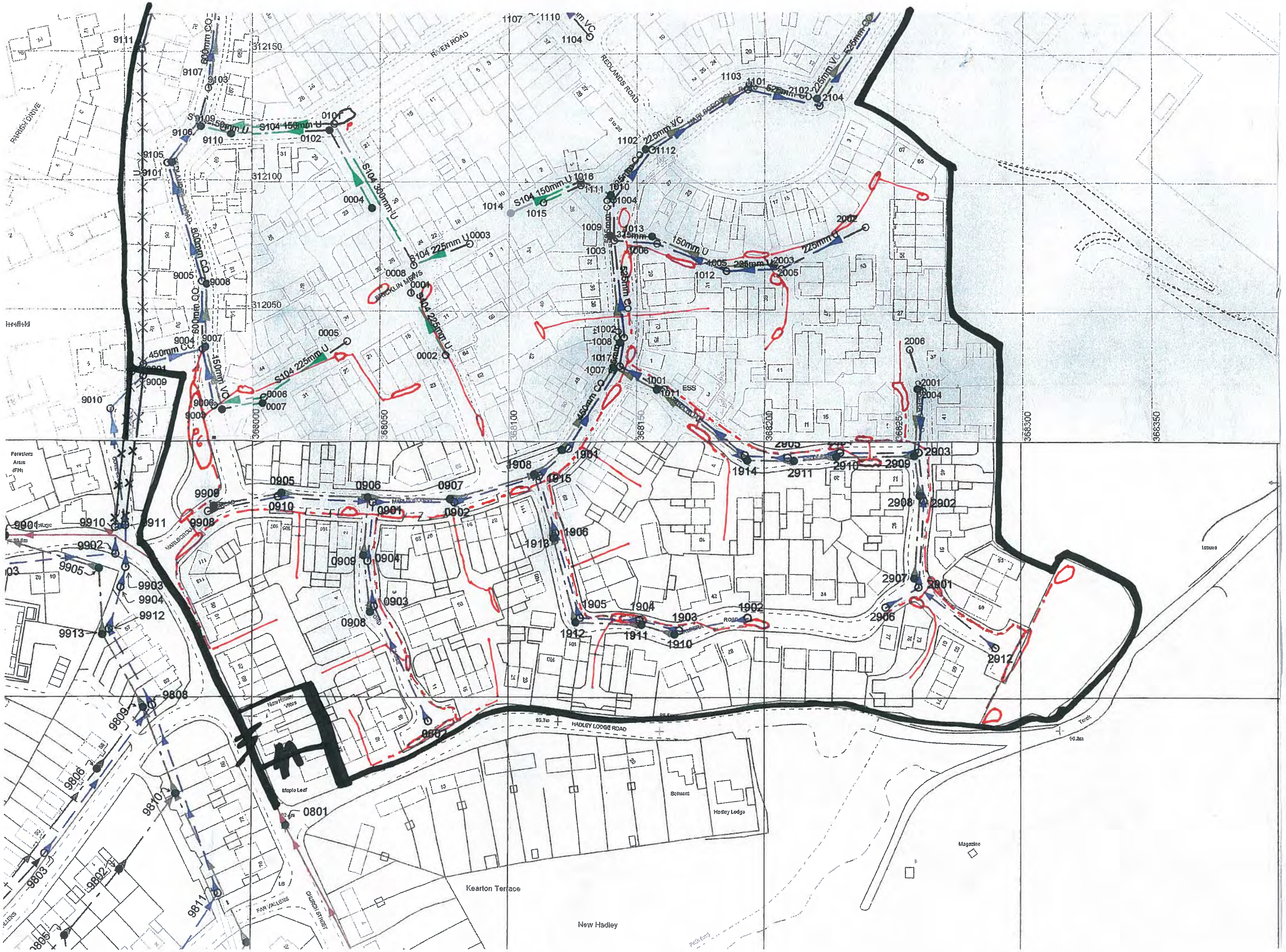


Case Study 2

Marlborough Road

Surface Water Sewer Plan

Scale : 1:2500



New Hadley
Kearton Terrace
HADLEY LODGE ROAD
Hadley Lodge
Maple Leaf
New Hadley Villas
CHURCH STREET
FAR VALLENS
PARISH DRIVE
REDLANDS ROAD
RAVEN ROAD
BRICKLIN MEWS
MARLBOROUGH ROAD
Foresters Arms (PH)
Magazine
Issues
Track
95.7m
S104 150mm U
S104 300mm U
S104 225mm U
150mm VC
225mm VC
450mm CO
600mm CO
525mm CO
368000
368050
368100
368150
368200
368250
368300
368350
312050
312100
312150

APPENDIX 3

Case Study 2 (Marlborough Road), Estimate.				
Item	**Standard Drainage**		**SUDS**	
	Qty	**£**	**Qty**	**£**
Pipework	2730m	255,175	2,145m	109,065
Manholes	97nr	105,550		
Gullies incl. connections	133 nr	30,590		
Catch Pits			20 nr	6,900
Gulley Pipework	399m	17,556		
Basins – Excavation			2,890m^3	7,803
Basins -Soft Spots and Fill			20m^3	638
Basins – Headwalls / Control Devices			12 no.	12,000
Excavation-Trimming of Swales and Basins			2,890m^2	7,803
Swales - Excavation			938m^3	4,878
Surplus Material – Disposal			2,075m^3	51,875
Topsoil / Seeding			2,890m^2	3,468
House Connection – Pipework (say 12m / house)	4,644m	204,336		
House Connection – Pipework (say 12m / house)			4,644m	204,336
Bricklin Mews (Type 1) (Area paved additional sub-base for porous paving)			1,240m^2	39,680
Driveway - Surface Course (40mm)	3525m^2	29,963		
Driveway - Binder Course (60mm)	3525m^2	35,250		
Driveway – Sub - base Course (Type 1)	529m^3	16,928	529m^3	16,928
Driveway – Additional Sub-base (Type 1)			529m^3	16,928
Porous Block Paving to Driveways			3525m^2	70,831
Driveway – Geotextile Membrane			3525m^2	4,935
'Cul de Sacs' - Surface Course (40mm)	6,095m^2	51,808		
'Cul de Sacs' - Binder Course (60mm)	6,095m^2	60,950		
'Cul de Sacs' – Sub - base Course (Type 1)	1828 m^3	58,496	1828 m^3	58,496
'Cul de Sacs' - Porous Block Paving (80mm)			5600m^2	179,200
'Cul de Sacs' – Geotextile Membrane			5600m^2	7,840
'Cul de Sacs' – Additional Sub – base (150mm)			840m^3	26,880
'Raised Platform' over 'swale pipe' road crossings			420m^2	7,140
Sub Total		**866,602**		**779,128**
Prelims 14%		121,324		109,078
Design Supervision 10%		86,602		77,913
Total		**1,074,528**		**966,119**
House Number	387			
Site Area	112,442m^2			
Density	34.4 Units/ha.			

APPENDIX 4

Case Study 2, Photographs.

Photograph G. Fairhurst

Brick paved street. Showing scope for use of porous paving and surface channel to a basin.

Photograph G. Fairhurst

Brick paved, unadopted parking court. Showing scope for porous paving and small basin.

Case Study 2, Photographs (continued).

Photograph G. Fairhurst

Brick paved square (adopted highway). Showing how bollards have been used to restrict the areas for vehicles and space available for use of SuDS features such as basins. Also showing scope for porous paving.

Photograph G. Fairhurst

Main spine road through the estate. Showing scope for: porous paving, swale on right and basins in traffic calming build-outs on left.

Case Study 2, Photographs (continued).

Photograph G. Fairhurst

Main spine road through the estate and 'village green' on left. Showing scope for: pond in green, swale instead of verge on right and basins in highway visibility splay.

Photograph G. Fairhurst

Green corridor through eastern part of estate. Showing scope for linear pond and/or basin as feature between 'kick about' area and highway and parking on left.